REMARKS

Claims 1-7 are all the claims pending in the application. Claims 1 - 3 are objected to. Claims 1 and 5 - 7 are rejected under 35 U.S.C. 102(b). Claims 2 - 4 are rejected under 35 U.S.C. 103(a).

Claim 1 has been amended to further include the limitations of eight platforms being at 45 degrees, eight arms, eight pairs of gripping jaws, a detecting means, and a control and management system. Claim 5 has been amended to limit the number of axes to between one and four. Claim 6 has been amended to further define the control and management system as including a central processing unit, a display, and a data storage and processing system. A number of minor changes have been made to claims 2 - 5, which are intended to correct the grammar or address other issues raised by the Examiner.

The specification has been amended to provide a better and idiomatic text. No new matter is added.

Claim Objections

Claims 1 - 3 are objected to because the following elements lack antecedent basis: *the platform* in claim 1, line 6; *the arms* in claim 1, line 7; *each gripping jaw* in claim 1, lines 8 and 9; *each arm* in claim 2, line 2; and *the geared motor* in claim 3, lines 2 and 3.

Applicants have amended claims 1 - 3 to overcome these objections and respectfully submit that these claims are now in condition for allowance.

Claim Rejections - 35 U.S.C. § 102

Claims 1 and 5 - 7 are rejected under 35 U.S.C. 102(b) as being anticipated by Urumov titled "A Machine for testing sheet specimens for fatigue under two-frequency loading conditions." Applicants traverse these rejections for at least the following reasons.

First, Applicants have amended independent claim 1 to include additional limitations including a detecting means for independent monitoring and actuation of the arms, and a control and management system. Applicant respectfully submits that the claims as amended are patentable.

Second, In order to achieve a reliable and realistic mechanical characterization (in terms of tensile, compression and fatigue behaviour) of anisotropic (directionally-dependent) structures when simultaneously subjected to multidirectional stresses, the apparatus must be capable of applying well-defined and uniform multi-dimensional stresses, dynamically programmed according to the performance requirements of the materials under test, so that the measured values correspond to real stresses. To attain this dynamic and "controlled" multi-dimensional stress the mechanical concept, systems integration and measurement method must be selected and designed according to the material's viscoelastic properties and use conditions. These characteristics cannot be found in the existing equipment and cannot be attained as an extension of the existing techniques: it requires a novel concept and a new experimental technique. The novelty of the proposed machine relies on this: based on a multiaxial arrangement, the invention is capable of performing uni, bi, tri or tetra-axial tests in tension, compression and fatigue, guaranteeing the real mechanical and fatigue behaviour of 2D complex anisotropic structures under combined stresses.

Applicants' proposed multiaxial arrangement is capable of performing uni, bi, tri or tetra-axial tests in tension, compression and fatigue, guaranteeing the real mechanical and fatigue behaviour of 2D complex anisotropic structures under combined stresses.

The Urumov mechanical concept, operating principle, and measurement method are completely different from the proposed multiaxial universal testing machine. Urumov's machine is based on a quadrangular base plate and a supporting ring frame that carries eight elastic rings (dynamometers) to which inertial vibrators are fixed and to which the specimen is connected (through a gripping system comprising grips, rods and tension nuts). The machine performs synchronous and in-phase vibratory loading (it can operate in single or two- frequency loading) in all axial directions, promoting longitudinal vibrations in the specimen. To induce lateral vibrations, the inertial vibrator has to be mounted directly on the test specimen *(page 1, paragraph 3, lines 1-18)*.

Applicants' proposed multiaxial machine is based on a horizontal octagonal layout, as supporting structure, where four horizontal axes, each one with two arms, result in a final arrangement of eight gripping jaws at 45° relative to one another to which the specimen is attached. The proposed machine performs uni, bi, tri or tetra-axial tests in tension, compression

and fatigue. In other words, Applicants' invention is not limited to uni-axial or bi-axial testing, as are the prior art machines. Relying on electric actuators with speed reducers, coupled to linear drives in series with load cells and gripping jaws to apply the force to the specimen, Applicants' machine performs synchronous or asynchronous multiaxial loading and extension, according to the programmed test.

The radial orientation is obvious in both cases, and expected when a multiaxial evaluation is the aim, but this is the only similarity between Urumov's machine and Applicants' invention. In addition to these key technical differences, the suitability of Urumov's machine to assess the mechanical and fatigue behaviour of anisotropic structures (such as textiles, composites and laminates) is doubtful, as in the paper document the sheet-like and rod-like specimens referred are typically isotropic materials *(page 2, paragraph 3, line 1-16; page 3, paragraph 2, line 4).*

Theoretically it is possible to extend the multiaxial testing machine to n axes, keeping all the measurement capabilities, as claimed in claim 5. Spite the possibility of extending the proposed multiaxial concept to a 20 axes machine (claim 5), the construction and dimension of such apparatus is unpractical and does not lead to an added value in terms of measuring equipment for 2D complex anisotropic structures (such as textiles, composites and laminates) as, generally they are produced up to eight directions.

Claim Rejections - 35 U.S.C. § 103

Claims 2 and 3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Urumov in view of Boehler et al. titled "A new direct biaxial testing machine for anisotropic materials". Applicants traverse these rejections for at least the following reasons.

First, Applicants have amended independent claim 1, from which claims 2 and 3 depend, to further include the limitations of a detecting means and a control and management system. Neither Urumov nor Boehler et al. include such limits. Therefore, Applicants respectfully submit the claims are patentable as amended.

Urumov

Second, as previously stated, Urumov's machine, apart form the horizontal octagonal arrangement, has no technical characteristics - mechanical concept, operating principle or measurement method - similar to the proposed multiaxial universal testing machine. Considering that these are the base design features affecting the system dynamics and

consequently the machine performance capabilities and novelty, Urumov's machine cannot be considered prior art to Applicants' invention and cannot be regarded as a baseline that one skilled in the art can use to develop Applicants' proposed multiaxial machine. Moreover, the characteristics of the mechanical concept and measurement method devised to assess the mechanical and fatigue behaviour of sheet materials is inadequate for anisotropic structures (such as textiles, composites and laminates).

Boehler et al

The biaxial machine described by Boehler et al. is based on a vertical octagonal frame where 4 double-acting screw driven pistons are rigidly supported to perform bi-axial tests (two mutually perpendicular directions). Due to equipment mechanical constraints associated to the vertical arrangement of the machine and to the material dynamics under test (namely bending and shear properties), the extension of this machine to *n* axes to perform the tests performed by the multiaxial machine (uni, bi, tri or tetra-axial tests) is not feasible: under these conditions, path alignment and uniform stresses distribution are compromised, leading to unrealistic test results.

As already stated, the radial orientation is obvious when a multiaxial evaluation is the aim, and the three machines (Urumov's, Boehler's et al. and the proposed multiaxial) have radial arrangements. However, in regards to the key technical features -mechanical concept, operation principle and measurement method- all machines are different and use different mechanical solutions to implement the required functions, thus not being able to be regarded as "optimized" or "upgraded" versions.

The proposed multiaxial testing machine was designed to avoid bending and shear problems and ensure a correct path of the arms/grippers. Due to the vertical installation, Boehler's et al. biaxial machine was equipped with means to compensate the deadweight of each horizontal arm/gripper to avoid bending of the specimen (*page 2, General features, lines 16-20*). Boehler's et al biaxial machine is only capable of performing tensile tests (as new gripping systems have to be designed to perform compression tests) (*page 2, Mechanical Concept, line 9-11)* and no mention or suggestion is made in the document to fatigue tests (cyclic testing). Applicants' multiaxial machine is capable of performing these types of test (tensile, compression and fatigue) without altering the gripping system.

The technical characteristics of the Boehler et al. machine allow for a testing speed between 0.003 and 0.3 mm/min with the full stroke of the piston limited to about 245 mm (*page 3 Drive unit, paragraph 1, lines 11-15; paragraph 2, lines 1-4*). The multiaxial machine was designed to allow a testing speed adjustment between 5 and 500 mm/min, with a 0.1 mm displacement resolution and a jaws displacement range varying between 260 to 700 mm. To promote stress and strain fields homogeneity in the central test region of the cruciform specimen (which is associated with rigid claimed heads), Boehler et al. devised an off-test testing device (page 3, Connection Machine Specimen, paragraph 1, lines 1-26); the proposed multiaxial machine uses an articulation head to minimize horizontal misalignments, thereby avoiding the concentration of strain and stress fields in the clamping area, promoting homogeneity in the central zone of the specimen.

Claim Rejections - 35 U.S.C. § 103

Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Urumov and Boehler et al, as applied to claims 1 - 3 and 5 - 7 above, and further in view of Ramaswamy et al. (6,247,370). Applicants traverse these rejections for at least the following reasons.

First, applicants have amended independent claim 1, from which claim 4 depends, to include the limitations of a detecting means and a control and management system. Neither Urumov nor Boehler et al. include such limits. Therefore, Applicant respectfully submits that claim 4 patentable as amended.

Second, the mechanical solution proposed in Claim 4 (relying on the function of a dry bearing to support the slide carriage) relates to the linear movement responsible for the correct alignment of the specimen under test and is vital to the correct measurement of the forces involved in the test. The components involved in this mechanical solution are an integrated part of the whole mechanical concept and contribute to the performance of the multiaxial testing machine. Therefore, it is not clear for the Applicants Urumov and Boehler et al. teach that could be modified by one skilled in the art using the disclosure of Ramaswamy et al. Moreover, it should be noted that the dynamic behavior of the whole proposed mechanical system depends on the components' behavior but also on their interaction within the system. This is the reason why the extension of an apparatus to n axes, although theoretically possible when using the same mechanical concept and arrangement, is only feasible when system dynamics is unchanged.

Ramaswamy et al.

The biaxial machine of Ramaswamy et al. is based on a horizontal cruciform arrangement, where two pairs of juxtaposed grippers, mutually perpendicular to each other, move in slideways, actuated by a vertical drive, performing a synchronous biaxial extension to assess bi-dimensional stress relaxation (Column 4, lines 10-25). When compared to the multiaxial testing machine, the radial horizontal arrangement is obvious (Ramaswamy et al, machine with a horizontal cruciform arrangement and the multiaxial machine with an octagonal one), but the mechanical concept, systems integration and measurement method are completely different. As already stated, the multiaxial machine was designed to perform synchronous or asynchronous loading (CRE), extension (CRE) and cyclic tests in one, two, three, or four directions. The mechanical solutions adopted for all the sub-systems that integrate the whole mechanical concept were, therefore, developed to guarantee that the real mechanical and fatigue behavior of 2D anisotropic complex structures was assessed under combined stresses.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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23373
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Date: September 5, 2008